

## Atomic System for Quantum Secure Communications, Phase I

Completed Technology Project (2018 - 2019)



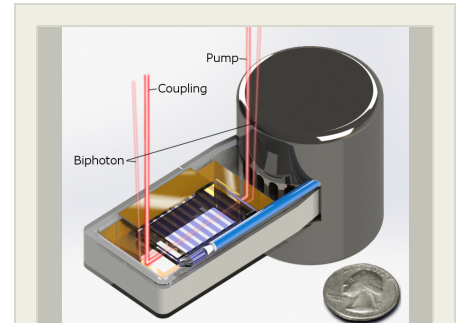
## Project Introduction

The future of secure ground-space and space-space communications relies on development of quantum secure communications (QSC) systems. ColdQuanta proposes to develop QSC devices based on compact, robust vacuum systems containing dense ensembles of cold, trapped rubidium atoms. In particular, we propose to develop a source of high-flux, high-coherence entangled photon pairs (biphotons). These biphotons can be used to transmit information in a provably secure manner that is consistent with existing QKD protocols and other real-time secure information transfer protocols. The proposed atomically sourced biphotons outperform photon pairs from existing solid-state sources by over a factor of 1000 in coherence time and spectral linewidth. The narrow spectral linewidth of the atomically sourced biphotons makes them compatible with direct interfacing with downstream atomic systems, opening vast new vistas in the potential for long-range QSC and quantum networking. A second direction that further pushes the state-of-the-art in highly-coherent quantum optical systems for QSC is our second proposed device that provides efficient storage and recall of single-photon states. The single photons are stored in a coherent collective excitation of a cold atomic ensemble and can later be retrieved when the downstream QSC system is ready. Together, these devices represent a dramatic step forward in the quality of commercially available QSC hardware components. Nevertheless, the parallel development of the devices will be highly efficient due to their shared reliance on identical underlying cold atom hardware. These devices (and potentially several other related quantum optical devices) will be different laser and optical packages wrapped around an identical vacuum system for production of atomic ensembles with extremely high optical density. Phase I will demonstrate the underlying atom ensemble hardware and will complete system-level designs of the proposed QSC hardware components.

## Anticipated Benefits

Quantum communications provides provably secure transmission of information, something that can't be ensured in any other way. Thus, the future of ground-space and space-space communication will be performed over quantum links. The Chinese MICIUS satellite has paved the initial path in the direction of employing quantum protocols for secure communications. The innovation proposed here would provide part of the necessary package for NASA to return to the fore-front of secure space communications.

Implementing and utilizing quantum communication technologies (QCT) is of great interest to companies and governmental entities that transfer highly sensitive information as part of their operations (such as government agencies, financial and research firms, medical companies, stock trading services, etc.). The benefits provided by the proposed technology position it well for rapid integration into existing quantum communications applications.



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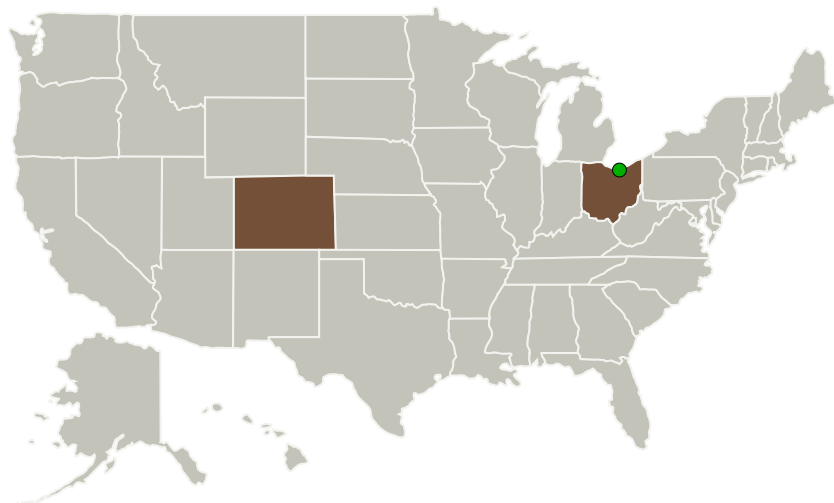
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## Primary U.S. Work Locations and Key Partners




Organizations Performing Work	Role	Type	Location
ColdQuanta, Inc.	Lead Organization	Industry	Boulder, Colorado
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

## Primary U.S. Work Locations

Colorado	Ohio
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## Project Transitions

 **July 2018:** Project Start **February 2019:** Closed out

## Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/140938>)

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

ColdQuanta, Inc.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Principal Investigator:**

Thomas Noel

**Co-Investigator:**

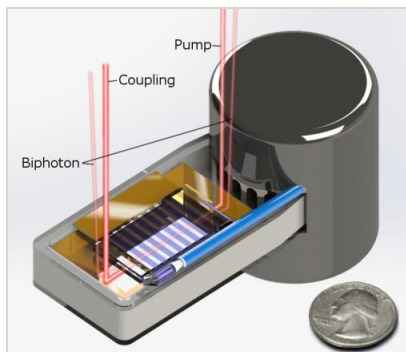
Thomas R Noel

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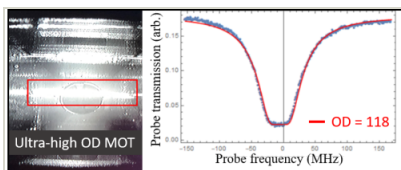


## Images



### Briefing Chart Image

Atomic System for Quantum Secure Communications, Phase I  
(<https://techport.nasa.gov/image/126147>)

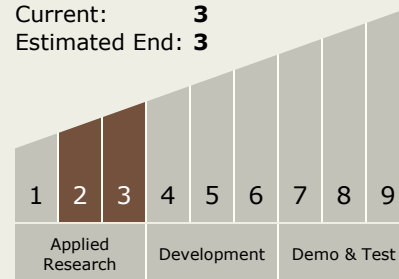


### Final Summary Chart Image

Atomic System for Quantum Secure Communications, Phase I  
(<https://techport.nasa.gov/image/134825>)

## Technology Maturity (TRL)

Start: **2**  
Current: **3**  
Estimated End: **3**



## Technology Areas

### Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.5 Revolutionary Communications Technologies
    - TX05.5.2 Quantum Communications

## Target Destination

Earth